

***Conceptual Framework, Monitoring Components, and Implementation of
the Cape Cod National Seashore Prototype Long-Term Ecosystem
Monitoring Program***

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Prepared by:

Carrie Phillips, Inventory & Monitoring Coordinator

Cape Cod National Seashore
99 Marconi Site Road
Wellfleet, Massachusetts 02667
508-487-3262

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Introduction

For the past six years, the National Park Service (NPS) and the Biological Resources Division of USGS have been developing a prototype long-term ecosystem monitoring (LTEM) program at Cape Cod National Seashore. We have developed a conceptual framework that provides a foundation for selecting monitoring objectives, worked collaboratively with researchers to develop long-term monitoring protocols, and started building the infrastructure and institutional capacity to sustain ecological monitoring efforts over the long term.

We are now beginning to transition from a developmental program into an operational program. The NPS Inventory & Monitoring Program has identified this transitional stage as an opportune time to seek expert review of a program's progress and direction. It is also an appropriate time to document the status of our program, and to identify some of the issues we will need to address over the next few years. The information that follows is intended to provide this documentation and to serve as a reference for reviewers.

Part I summarizes the history of the Cape Cod LTEM Program, and describes our responsibilities as a prototype program. Part II focuses on the ecological context for our monitoring objectives and incorporates the Conceptual Framework developed in 1999 (Roman and Barrett 1999) and its 2002 Update (Boland et al. 2002). These documents also provide summary and status information for each of the protocols and related studies we are pursuing. Part III summarizes the current status of the operational and administrative aspects of the program, and culminates with a brief list of issues we are likely to be addressing over the next few years. We have also included our Annual Administrative Report (FY2002) and Work Plan (FY2003) as an appendix to provide an example of how our program objectives translate into on-the-ground activities.

Part I: Introduction to the Cape Cod Prototype Long-Term Ecosystem Monitoring Program

Program History

The NPS has long recognized that park managers need scientifically sound information regarding the nature and condition of the natural resources under their care. In the early 1990s, the NPS embarked on an effort to institutionalize the kinds of inventory and monitoring activities that would help managers understand and protect the health of park ecosystems. In 1992, four parks were selected to host experimental or "prototype" long-term ecosystem monitoring (LTEM) programs. The objective was to gain experience in long-term monitoring design and implementation. In 1993, the NPS solicited proposals from which to select another seven prototypes. The goal was to develop programs that would represent different biogeographic regions, that would reflect a range of park sizes and settings, and that would include tests of the cluster or network approach in which a collection of similar parks would join together to comprise a prototype program.

Cape Cod National Seashore (CACO) submitted a proposal to represent the Atlantic and Gulf Coast biogeographic region (Cape Cod National Seashore 1993) in response to the 1993 call for proposals. The proposal emphasized four factors that qualified CACO for consideration as a new prototype:

- CACO contains the diverse array of coastal zone habitats found along the Atlantic and Gulf coasts;
- CACO is exposed to common threats (i.e. sea level rise and storms, external development pressure, ecosystem fragmentation);
- CACO possessed the staff and physical resources necessary to develop a scientifically credible plan; and
- CACO had extensive multidisciplinary data on which to base a monitoring program.

CACO was selected as one of the seven additional prototype programs and began receiving funding in 1996.

The CACO Prototype LTEM Program, as with the other Prototype LTEMs, was developed in partnership with USGS Biological Resources Division (BRD). USGS-BRD took the lead in building a conceptual foundation for the program and developing long-term monitoring protocols. These efforts were supported by annual budgets of \$150,000 to \$200,000 from 1996 through 2001. During that period, CACO focused on gradually building the capacity to implement the monitoring program for the long-term, and our annual budgets grew steadily until we began receiving our full allocation of \$702,000 in 2001. Throughout, USGS-BRD and CACO have collaborated closely on all aspects of the program including the conceptual framework, selection of monitoring projects, and protocol development.

In 2000 NPS broadened the Inventory and Monitoring Program to address all parks with significant natural resources. Based in part on the lessons learned from the prototype programs, particularly the cluster prototypes, the nation-wide strategy groups parks into 32 geographically-based networks. With the assistance of coordination, data management, and select scientific expertise provided at the network level, the parks in each of these networks will work together to monitor core ecological parameters, often referred to as "vital signs" of ecosystem health. With the advent of the network approach, the role of the prototypes expanded to include providing focused technical support to the networks and serving as "centers of excellence" for the National Inventory and Monitoring Program.

The following milestones describe the course of development of the Cape Cod LTEM Program over the preceding six years:

- In 1996 and 1997 the North Atlantic Coastal Laboratory was constructed at Cape Cod National Seashore to provide facilities for the Division of Natural Resource Management and the Cape Cod LTEM Program. Funding was provided by USGS-BRD and NPS.
- In 1996 a Science Board was assembled to participate in identification of monitoring objectives, and to evaluate and recommend sampling designs and methods. The Science Board consisted of six members from external agencies and academia, and provided expertise in diverse physical and ecological disciplines.
- In 1997 the first On-Site Research Coordinator (USGS-BRD) and Inventory and Monitoring Coordinator (CACO) were hired.
- In 1998 the program held a workshop to solicit focused input and recommendations from park superintendents and resource managers throughout the Atlantic and Gulf Coast biogeographic region.
- In 1999 USGS-BRD published Conceptual Framework for the Development of Long-term Monitoring Protocols at Cape Cod National Seashore (Roman and Barrett 1999). This document provides the scientific foundation of our program and an objective basis for selecting monitoring projects. (A copy is included in Part II.)
- In 1999 USGS-BRD and CACO developed the Cape Cod LTEM Protocol General Outline to provide guidance, identify required content, and promote structural uniformity among final protocols. (A copy is provided in Appendix B.)
- In 2001 CACO began providing technical support to the newly funded Northeast Coastal and Barrier Network. This support has included leadership of technical teams, helping to identify the core ecological parameters that will be monitored, providing review of proposals and reports, and providing technical assistance with development of specific protocols.
- In 2002 CACO developed an update to the 1999 Conceptual Framework (Boland et. al. 2000) which describes and updates the status of the monitoring protocols being pursued. (A copy is included in Part II.)
- At the close of FY2002, six monitoring protocols have been completed, 27 are in development, and of those 27, eleven are expected to be completed in FY2003.

Program Responsibilities, Goals, and Objectives

As a prototype program, we have responsibilities at a variety of levels. We are responsible for conducting long-term monitoring that is scientifically credible and responsive to the information needs of CACO's managers. We need to share our results with interpreters, partners, the local community, and the scientific community. We must ensure that our monitoring program includes the core ecological parameters being monitored by the Northeast Coastal and Barrier Network, and that the data are compatible to support Network-wide summaries and analyses. We must export our developmental work, technical expertise, and experience to the Network and the broader Atlantic and Gulf Coast biogeographic region. Where applicable and useful, we also need to share what we've learned with other prototypes and networks across the country. And finally, we must thoroughly document our activities and results in order to meet scientific standards, invite review, demonstrate accountability, and assist those who will implement this program in the future.

These responsibilities can be met if we maintain our focus on the following goals:

- Develop a scientifically credible and sustainable program that is ecosystem-based and issue-oriented. This means that our program should be designed to:
 - detect and understand change;

- forecast potentially adverse changes;
- inform whether and when management intervention is necessary; and
- evaluate the effectiveness of management actions.
- Develop monitoring protocols that address ecological and management issues relevant to CACO, that include systems common among parks in the Network and broader geographic region, and that are based on rigorous testing of inventory and monitoring methods.
- Conduct focused studies that identify core ecological parameters and help interpret monitoring results.
- Communicate results, share technical expertise, and collaborate with those having common monitoring or scientific objectives.

These responsibilities and goals are considered with the direction provided in the 1999 Conceptual Framework to formulate specific program objectives. Because we are still in a developmental phase, our annual objectives have evolved with each successive year. As we transition from FY2002 to FY2003, our specific program objectives are as follows:

1. Assess and monitor the integrity of estuarine and salt marsh ecosystems.
2. Assess and monitor the integrity of beach, spit, and barrier island ecosystems.
3. Assess and monitor the integrity of pond and freshwater wetland ecosystems.
4. Assess and monitor the integrity of coastal upland ecosystems.
5. Assess and monitor park-wide and multiple-system indicators of ecosystem integrity.
6. Integrate monitoring efforts and results across ecosystems.
7. Share information, report findings, and document program activities.
8. Provide focused technical assistance to the Northeast Coastal and Barrier Network, to other networks and parks within the Atlantic and Gulf Coast biogeographic region, and to other entities with common monitoring objectives.
9. Develop and sustain appropriate resources and infrastructure to ensure program objectives can be met now and into the future.

References Cited

Boland, K., R. Cook, E. Gwilliam, C. Phillips, J. Portnoy, and S. Smith. 2002. 2002 Update of the Conceptual Framework for the Development of Long-Term Monitoring Protocols at Cape Cod National Seashore. 74pp.

Cape Cod National Seashore. 1993. A Proposal for Cape Cod National Seashore to serve as a Prototype Monitoring Program for the Atlantic/Gulf Coast Biogeographic Region. 91pp.

Roman, C.T. and N.E. Barrett. 1999. Conceptual Framework for the Development of Long-term Monitoring Protocols at Cape Cod National Seashore. USGS Patuxent Wildlife Research Center, University of Rhode Island. 59pp.

Part II: Long-Term Ecosystem Monitoring at Cape Cod National Seashore: The 1999 Conceptual Framework and the 2002 Update

Cape Cod is a large glacial peninsula that extends 60 miles into the Atlantic Ocean from the coast of Massachusetts. CACO encompasses 44,600 acres of marine, estuarine, fresh water, and terrestrial ecosystems. Marine and estuarine ecosystems include barrier islands, beaches, spits, tidal flats, salt marshes, salt ponds, and soft-bottom benthos. Freshwater ecosystems include kettle ponds, vernal pools, sphagnum bogs, forested swamps, and dune slack wetlands. Terrestrial systems include pitch pine and scrub oak barrens, pitch pine forests, oak forests, heathlands, dunes, and grasslands. Many of these habitats are globally uncommon and the species that occupy them are correspondingly rare.

During the past three centuries Cape Cod ecosystems have been altered profoundly by human occupation. For example, construction of dikes and ditches in estuaries has changed natural tidal regimes resulting in water quality degradation and loss of native plant and animal species. Beach and dune stabilization efforts have interfered with natural processes shaping shorelines. Discharges from nonpoint sources of pollution such as landfills, septic systems, and golf courses have adversely affected surface and ground-water quality. Extensive agriculture, deforestation, grazing, and re-vegetation with exotic species has left a landscape dominated by anthropogenic influences. More recently, fire suppression has altered the distribution and volume of the heathland and pitch pine communities that predominated before European settlement. Some of the highest ozone levels in the northeast have been recorded at CACO. The park includes many municipal and private in-holdings and is surrounded by varying densities of residential and commercial development. Add the over 5 million visitors that come to CACO each year, and the significance of the challenges facing CACO managers becomes apparent.

In this setting of diverse resources and complex management issues, the ability to develop a credible and relevant monitoring program has rested on the foundation provided by the 1999 Conceptual Framework. The Conceptual Framework uses design matrices to model CACO's ecosystems in terms of agents of change, stresses, and ecosystem responses. These conceptual models illustrate linkages within systems and provide an objective basis for identifying monitoring components. The Framework is organized in two parts: Part I describes an ecosystem-based, issue-oriented approach to long-term monitoring and includes the conceptual models. Part II summarizes the monitoring protocols proposed as the initial core of the Cape Cod LTEM Program. The 2002 Update describes developments in the scope, focus, and status of protocol development efforts and thus amends Part II of the Framework. At this point, we refer the reader to these two documents which, if not physically included, are incorporated by reference.

Part III: Program Implementation

Administration and Relationship to the Division of Natural Resource Management

The CACO Prototype LTEM Program is administered by the Division of Natural Resource Management (NRM) and housed at the park's North Atlantic Coastal Laboratory along with other NRM staff. The program is supported by all CACO divisions:

- the Division of Administration provides assistance with hiring and personnel management, development of Cooperative and Inter-Agency Agreements, payroll, purchasing, and other related functions;
- the Maintenance Division maintains the North Atlantic Coastal Laboratory and all vehicles; and
- the Division of Interpretation and Cultural Resources provides advice and assistance on outreach, and helps ensure ground disturbing activities (such as installation of monitoring wells) are in compliance with cultural resource protection laws and policies.

Integration with NRM has been key to the program's growth and productivity over the past six years. The NRM Division Chief and staff:

- manage the laboratory;
- perform analyses of water, soil, sediment, and plant tissue;
- train LTEM staff and technicians;
- are lead scientists on some protocols and collaborate with prototype staff on others;
- mentor developing prototype staff;
- manage GIS and remote sensing information;
- help with recruitment and hiring;
- provide administrative support;
- help manage the budget; and
- in general, provide expert guidance and advice on all aspects of the program.

The prototype has benefitted NRM by complementing the mix of scientific skills and expertise available to address resource issues, and by generating more detailed information about the park's resources. We are also able to meet both programs' objectives more efficiently by sharing resources where appropriate. Examples include vehicles, the chemistry lab tech position, and lab supplies.

At the same time, we are careful to ensure that Inventory and Monitoring funds are dedicated to long-term monitoring and are not diverted to unrelated projects. Our ability to maintain the integrity and fiscal accountability of both programs depends on diligent and conscientious collaboration between the Division Chief and the Prototype Coordinator, and the support of the Superintendent and Deputy Superintendent of the park.

Staffing and Budget

As discussed in Part I, the CACO Prototype LTEM Program began receiving our full funding allocation of \$702,000 in 2001. Our most significant expenditures have been personnel, cooperative agreements, and operations and equipment. As we transform from a developmental to an operational program, we expect to dedicate significantly more of our budget to salaries and significantly less to cooperative agreements. At this time we do not plan any more purchases of expensive equipment (such as vehicles and analytical instruments), but we expect our small equipment purchases (such as binoculars, field meters, computer work stations) and our use of

consumable field and lab supplies (such as containers and reagents) to increase slightly over the next year or two as we bring more protocols on line. As a result, we expect our operations and equipment costs to stay the same or rise slightly, and then decline somewhat as we complete acquisition of durable equipment. These expectations are reflected in the breakdown of our FY2002 expenditures and our planned budget for FY2003:

| % of Budget Dedicated to Each Major Category | Actual FY2002 | Planned FY2003 |
|---|----------------------|-----------------------|
| Personnel | 44 | 76 |
| Cooperative Agreements | 46 | 11 |
| Operations/Equipment | 8 | 10 |

Salaries for year-round staff will be our biggest expenditures in the coming years. In 1997 a Transition Plan was prepared which described the incremental addition of staff needed to develop an operational program by 2001. In 2001, re-assessment of the Transition Plan indicated that the proposed staffing would not be sustainable (modeled over a five-year period) without significantly depleting operational funds and precluding our ability to hire seasonal technicians. The three key factors accounting for the difference between the predictions in the 1997 Transition Plan and the 2001 re-assessment were:

- the Transition Plan did not take into account that some of the individuals hired at the planned grade would come in at middle to high step levels;
- the analytical chemistry demands of the program cannot be met without dedicated staffing - this need has been satisfied through a chemistry laboratory technician position shared by NRM and the prototype; and
- Cape Cod is likely to be added to the geographic area receiving Boston Locality Pay - currently, this is forecast to occur in FY2004.

At the time of the analysis in 2001, the unfilled positions were the Data Manager, Plant Ecologist, Physical Scientist, and two year-round biotechs. The Plant Ecologist and Physical Scientist had been lost to turnover, and the Data Manager and biotechs had not yet been hired. We re-examined these vacant positions to determine how we could meet our needs without exceeding our budget or paralyzing the program with a lack of operational funds. There was unanimous agreement within the program that our vegetation monitoring needs required in-house, full-time expertise. As a result, we concluded that the Plant Ecologist position should remain in our staffing plan. We also decided to change the two unfilled biotechs to term positions to provide flexibility (please see concluding paragraph). We dedicated much of 2002 to exploring ways to meet our data management and physical science needs other than through full-time staff. Ultimately, we concluded that our data management needs could not be met without at least half-time to full-time in-house expertise at the GS-11 level. We restored this position in our staffing plan, developed an agreement with the Northeastern Coastal and Barrier Network to share support of the position (75% CACO/25%Network), and are currently recruiting. We plan to meet our physical science needs by hiring a GS-5/7 technician and working with USGS-WRD and the new Regional Hydrologist to provide mentoring and technical assistance on an as-needed basis. Our current and planned positions are summarized in the table below.

| Position | Brief Summary of Duties | Incumbent |
|-----------------------------------|---|--------------------|
| Coordinator; GS-12 | coordination, supervision, integration, reporting | Carrie Phillips |
| Budget Technician; GS-6 (PT) | budget, payroll, field assistance | Chris Pearson |
| Data Manager; GS-11 | data management, integration, reporting | to be filled in 03 |
| Wildlife Ecologist; GS-11 | wildlife protocols, analysis, reporting | Bob Cook |
| Plant Ecologist; GS-11 | vegetation protocols, analysis, reporting | Steve Smith |
| Aquatic Ecologist; GS-7/9 (SCEP) | aquatic ecology protocols, analysis, reporting | Evan Gwilliam |
| Wildlife BioTech; GS-5 | wildlife protocols, data collection | Kelly Boland |
| Chemistry Lab Tech; GS-5 (Term) | chemical analyses | Judith Oset |
| Hydrology Tech; GS-5/7 (Term) | physical science protocols, data collection | to be filled in 03 |
| Aquatic Ecology Tech; GS-5 (Term) | aquatic ecology protocols, data collection | to be filled in 03 |

In addition to the permanent and term positions listed above, protocol implementation requires a significant influx of seasonal staff and volunteers. For example, we supported three seasonal biotechs and four Student Conservation Association (SCA) volunteers during the 2002 season at a total cost of \$52,610, and plan to hire five seasonal biotechs and seven SCAs or other volunteers in 2003 at a predicted cost of \$89,100.

As discussed in the section addressing program administration, we are also dependent on the contributions of NRM staff. As the Aquatic Ecologist grows into his position our dependence on the NRM Senior Ecologist for protocol implementation will be reduced, but we will still need his guidance and mentoring for the aquatic ecology elements of the program. Similarly, filling the Data Manager position will reduce our need for data management assistance from the NRM GIS specialist, but again, we will continue to rely on him to help with our GIS and GPS needs. We will also remain dependent on the NRM Chemist to provide laboratory management, training, supervision of the laboratory technician, and analytical expertise. In addition to these specific roles, NRM scientists contribute tremendous ecological expertise and guidance to the prototype program. The absence of these contributions would diminish our ability to implement some protocols, particularly the water quality and atmospheric deposition components, and would hamper integrated interpretation of monitoring results.

Taking into account the revised staffing plan reflected above, we are unlikely to be able to continue at our present level of activities (as reflected by operational and seasonal personnel costs), absorb Boston Locality Pay, and remain within our current budget over the next five years. All the protocols being developed cannot become operational at this time. Careful planning will be needed to prioritize our monitoring needs.

Data Management

As mentioned above, we have investigated a variety of ways to meet our data management needs including training a SCEP student and contracting. Ultimately, we determined that the breadth and complexity of our data required an on-site data manager with significant expertise in Microsoft Access and a biological background. The Network is also in need of Access expertise

and has agreed to support 25 percent of the position. We are currently recruiting for a GS-401/408-11 with strong database skills to meet our data management needs. During this time, we have been fortunate to have the support of the NRM GIS Specialist who has ensured the security of our data, established naming conventions and archiving procedures, and outlined the elements of a data management plan. We also received tremendous data management assistance and guidance from Alan Williams, the data manager from the Shenandoah Prototype LTEM Program. Alan came for a three week detail during the summer of 2002 and continues to provide assistance on an as-needed basis. The data management assessment that follows is summarized from the report prepared at the conclusion of his detail.

Our program stresses the linkages within and across ecosystems. As a result, meaningful interpretation of the results of one protocol will rely on integrated analysis with the results from a suite of other protocols. These complex analyses of multi-disciplinary data will be facilitated through an integration of the databases associated with each protocol. At the same time, each protocol involves collection of unique data through a variety of data collection and recording methods, thus requiring a variety of entry, processing, and verification methods. This multi-level complexity poses sophisticated challenges for data management and database design.

In addition to developing a comprehensive data management system, there are specific conditions that should be remedied to improve the status of our data. Currently, we are using multiple files for storing data for a single protocol or project which complicates temporal analysis. We also do not have a standard system for referencing sampling locations which interferes with integration across protocols. And lastly, the majority of our data is in Microsoft Excel and needs to be imported to Access to meet NPS standards and facilitate development of an integrated database for the program. Our strengths rest in the dedication and sophistication of our scientists with respect to data management. Each has had training in Access, has implemented appropriate QA/QC procedures for their data, and embraces the vision of multi-disciplinary and integrated databases. We are also fortunate that our existing data sets, some of which span a decade or more, have been meticulously maintained. And lastly, we have emphasized the use of automated data collection where possible and have a data archive on the local area network with secure back-up procedures.

The status of individual databases using or migrating to Access is summarized below. All other data sets are still in Excel or some other format.

Kettle Pond Water Quality: An Access format has been designed and several years of data have been converted from Excel. This is our longest running database and there are still several more years of data that need to be imported.

Aquatic Turtles: An Access format has been designed, extant data imported, and new (2002) data entered using the new format. Staff has been working with the data in the new format with trouble-shooting assistance from Alan Williams.

Coastal Forest Vegetation: An existing Access database has been revised, existing data has been converted, and new (2002) data entered using the new format.

Salt Marsh Vegetation: An Access format has been designed, one year of data imported, and new data (2002) entered using the new format.

Landbirds - Point Counts: The cooperators on this study were already using an Access template developed by Steve Fancy (NPS I&M). No additional database design or revision is needed.

Small Mammals: The small mammal data is in an operational Access database developed in-house. No additional design or revision is needed.

Meso-Mammals: The cooperators on this study were already using Access for their data and no revision or re-design is needed.

In addition to developing a comprehensive data management plan and beginning to construct an integrated data management system, there are several discrete high priority tasks we will undertake once our Data Manager is on board and prior to the next field season:

- standardize sampling location names and codes;
- standardize observer names;
- review the field forms and develop a standardized header with date, site, and observers as common fields;
- standardize and clean-up data currently in Excel or other formats;
- establish program-wide standards for meta-data and QA/QC to be applied at the protocol level;
- establish standards and procedures for ensuring that field forms, electronic data sets, and automated data summaries and reports are clearly linked to the version of the protocol in effect at the time the data was collected;
- develop master storage copies of data sets that are clearly differentiated from derived products and working data sets;
- store available electronic documentation (protocols, field forms, etc) with the master storage copies of the data; and
- review network security settings to minimize the vulnerability.

Key Relationships and Partnerships

The Cape Cod LTEM Program has been built through partnerships with agencies, academic institutions, and non-governmental institutions. As discussed in Part I, USGS-BRD has been an integral part of the Cape Cod LTEM Program. Entities that are cooperating on protocol design, related studies, and monitoring efforts include:

- USGS-BRD Patuxent Wildlife Research Center
- USGS-Water Resources Discipline, Hydrologic Investigations Section, MA-RI District
- USGS-Geological Division
- University of Massachusetts, Amherst
- University of Rhode Island
- Virginia Tech
- Harvard Forest, Harvard University
- Massachusetts Division of Fish and Wildlife
- Cape Cod Commission
- Institute for Bird Populations
- Massachusetts Audubon

We refer to the 2002 Conceptual Framework Update to identify the principal investigators and cooperators for each protocol.

As USGS-BRD transitions out of its lead role in protocol development, the NPS North Atlantic Coastal Cooperative Ecosystems Studies Unit (CESU) at the University of Rhode Island is providing increasing assistance with finding and selecting cooperators, ensuring appropriate peer-review of draft protocols and related reports, collaborating on implementation and analysis for

specific protocols, and providing expert scientific guidance and review in general. We are extremely fortunate that Dr. Charles Roman, the lead for USGS-BRD, has become the Research Coordinator of the CESU; as a result, the transition has been seamless and nearly invisible.

The Cape Cod LTEM Program looks for opportunities to integrate efforts with other organizational units within NPS as well, particularly the Northeastern Region's Inventory and Monitoring Coordinator and the Northeast Coastal and Barrier Network. For example, development of the Geomorphic Shoreline Change protocol was dealt a severe blow this past summer with the death of Dr. James Allen, USGS, the principal investigator. Dr. Allen had extensive knowledge, data, and experience with CACO's beaches, bluffs, and controlling processes. His passing has created a tremendous void. The Network had been collaborating with Dr. Allen to extend the approach being developed for CACO to the rest of the Network. Now, the Network has taken the lead in completing a comprehensive protocol that can be applied throughout the Network, including CACO, and is also taking the lead in coordinating implementation. Another example of our integration with the Network is the shared support of the CACO Data Manager. The Network has a full-time Data Manager with significant expertise in dealing with diverse legacy data from numerous parks. As the Network begins implementation of monitoring protocols, they expect to need periodic assistance with the design and maintenance of Access databases. While their needs will be intermittent, familiarity with the data and consistency in approach will be critical. The compatibility of the Network's and CACO's data management needs has led to an agreement to share support of the CACO Data Manager position. And consistent with the purpose of prototype programs, the Network and coastal parks throughout the Northeastern Region are adopting the salt marsh vegetation and estuarine nekton monitoring protocols developed at CACO.

We have also taken advantage of opportunities to collaborate with local entities. For example, we cooperate with Massachusetts Audubon's Wellfleet Bay Wildlife Sanctuary to monitor nesting terrapins (*Malaclemys terrapin terrapin*), a State threatened species. We have also been able to collaborate with NRM and local entities to expand pond and estuarine water quality monitoring beyond park boundaries. The NRM Chemist is the lead for the project with partial support from a grant from the Community Foundation of Cape Cod. Partners include the Cape Cod Commission, lower Cape towns, Wellfleet Shellfish Department, and the Wellfleet Bay Wildlife Sanctuary. The LTEM Program has been able to help with volunteer training and laboratory assistance. This project will provide for a more comprehensive look at trends in pond and estuarine water quality on the lower Cape.

We anticipate significant partnership opportunities to develop in the future through CACO's emerging Atlantic Learning Center (ALC). We anticipate that the long-term ecological data generated by the LTEM Program will be an asset to researchers conducting studies through the ALC, and that some of the questions generated by our monitoring can be addressed through ALC partnerships. The ALC's laboratory, classroom, and dorm facilities will be developed within the same building complex as the North Atlantic Coastal Laboratory. This proximity should promote and facilitate collaboration among prototype staff and the researchers and educators working through the ALC.

Communicating Results: Outreach and Reporting

Translating LTEM data from databases and statistical analyses into formats that are accessible and understandable to others is an integral part of the Cape Cod prototype. In the late summer of 2001, we began meeting to discuss our outreach and reporting opportunities, responsibilities, and

priorities. We identified seven priority audiences, and listed some of the tools and products that might be most effective for delivering information to each group. The table below summarizes the audiences, the rationale for each audience's priority, and some of the key tools and products available.

| Audience | Why? | Primary Tools |
|--|--|---|
| CACO Managers | fulfill the purpose of the LTEM program | -regular protocol reports -analytical protocol or ecosystem reports -presentations at Squad meetings |
| Other CACO Divisions and Staff | support their role in stewardship of the park | -presentations at Leadership Seminars -training sessions for interpretive staff |
| NPS National I&M Program | share results and lessons learned; demonstrate accountability | -final protocols -regular protocol reports -analytical protocol or ecosystem reports -Annual Administrative Report and Work Plan |
| Northeast Coastal and Barrier Network | support Network-wide monitoring; collaborate on common objectives | -final protocols -regular protocol reports -analytical protocol or ecosystem reports -scientific papers |
| Parks and Networks in the Atlantic and Gulf Coast Biogeographic Region | share results and lessons learned; share expertise | -final protocols -regular protocol reports -analytical protocol or ecosystem reports -scientific papers |
| Local Entities (Towns, Cape Cod Commission, NGOs) | promote partnerships; promote understanding of park management decisions | -analytical protocol or ecosystem reports -fact sheets |
| Scientific Community (including other NPS I&M scientists) | receive feedback to improve the program; ensure scientific credibility | -scientific publications and presentations -publications in Park Science |

Regular Protocol Reports - These reports will be completed at a frequency commensurate with the frequency of protocol implementation. For example, a protocol implemented annually will generate reports annually; one implemented every three years will generate a report every three years. These reports will summarize the work performed and the information collected during the preceding field season. They should be brief and should emphasize timely documentation and preliminary data summation over in-depth analysis and interpretation. As protocols are finalized, we will develop a comprehensive schedule and standard format for these reports.

Analytical Protocol or Ecosystem Reports - These reports should provide analysis and interpretation of long-term ecological data from a single protocol or from a suite of protocols associated with the same ecosystem. They should communicate trends, the nature of change detected, and to the extent possible, include inter-disciplinary analysis to explain why the

observed change may be occurring. The frequency of these reports will depend on the frequency and statistical power of the protocols involved. In the next year or two, we will need to develop standards and procedures to ensure appropriate peer review of these reports.

Presentations at Squad Meetings - Presentations to senior management occur on an as-needed, as-requested basis. Content and depth vary depending on the topic (e.g. a general update versus an in-depth discussion of a critical management issue).

Presentations at Leadership Seminars - These occur roughly annually; the objective is to update other park divisions on program developments and new information.

Training Sessions for Interpretive Staff - This occurs annually and in collaboration with the Division of Interpretation and Cultural Resources. The Goal is to provide training to new seasonal staff as well as update returning interpreters. The topics covered include a broad range of NRM activities and not solely LTEM information. These sessions include a classroom presentation, field sessions, and field trips held during two of each District's staff meetings.

Final Protocols - As protocols are finalized, and again as they are revised, they are posted on the web site maintained by the National I&M Program.

Annual Administrative Report and Work Plan - This document is produced after the close of each fiscal year and provides an overview of specific activities, plans for the coming year, and budget information. In addition to documenting accountability for our funding, these reports have become a valuable tool for program planning and management.

Scientific Papers and Presentations - Where appropriate, analytical protocol or ecosystem reports will be developed into manuscripts for submission to peer-reviewed scientific journals. The objective is to communicate technical information to peers in the scientific community, and to receive the feedback inherent in peer review. Presentations at scientific societies serve a similar purpose but may occur more frequently and with more preliminary results.

Fact Sheets - Our objective is to provide information in a manner that is understandable to the intelligent but uninformed audience. Initial development efforts have evolved into "Seashore Science" rack cards. We will be meeting with the Division of Interpretation and Cultural Resources during the first quarter of FY2003 to refine this outreach tool.

Publications in Park Science - Submissions to Park Science are similar in focus to scientific papers and the analytical protocol or ecosystem reports. However, in Park Science, we would emphasize the information of most interest and relevance to other NPS scientists and natural resource managers.

Two other activities we are pursuing are a web site and periodic symposia or workshops. There are many other tools available for communicating the results of long-term monitoring including periodic presentations to local groups, working with local reporters, and providing content for the annual park newspaper produced for visitors. There are also a variety of more technical reports that have been, or will be, prepared periodically such as study plans for protocol development, protocol assessments, and recommendations for future monitoring based on protocol field testing.

For the past two years our annual work plans have included reporting as a performance objective. The scheduled activities listed under this objective identify the specific reports and outreach activities to be produced in the coming year.

Upcoming Issues and Questions

As we make the transition from a developmental phase to an operational phase, we are certain to encounter many scientific and programmatic issues and questions. Currently, there are a handful of issues which we know we will face within the next few years, and on which we are soliciting advice and comment.

Program Scope: The 2002 Conceptual Framework describes 33 developing protocols. The extent to which this breadth of monitoring activities will fit within our capacity for long-term implementation will not be known until more protocols are finalized, field tested, and revised accordingly. None the less, it is highly likely that we will not be able to include all of these protocols within our core long-term monitoring program. We expect that decisions regarding what to retain and what to abandon will consider the frequency and intensity of the monitoring methods (cost and staffing required), the veracity of the information produced, the linkages among the various protocols, and the contribution of each to our ability to detect and understand long-term trends relevant to management issues. In FY2003 we will begin planning a series of workshops with staff and technical advisors to address this issue. Any suggestions regarding how we might approach these decisions, or other factors we should consider would be appreciated.

Inter-Disciplinary Study Areas: Ecological relationships and linkages are at the core of our program's approach and scientific philosophy. Further development of the nascent Inter-Disciplinary Study Area concept would add another layer of integration onto our ecosystem-based approach (please refer to the 2002 Conceptual Framework Update for a description of the ISA concept). Any thoughts or recommendations at this early stage would be welcomed.

Marine Sub-tidal Systems: CACO's boundary extends one quarter of a mile off shore. However, outside of the estuaries, our program does not consider sub-tidal systems. Inventory and monitoring data describing the nature and condition of near-shore sub-tidal marine systems could be important to management if new fisheries (such as those involving the use of scrapes or bottom trawls) or recreational activities (such as a revival in the demand to use personal watercraft within the park) develop that are likely to affect these systems. This kind of data would be particularly critical in the unfortunate event of an oil spill. Given the current limitations of our resources and the existing scope of our program, we anticipate that developing appropriate inventory and monitoring information for near-shore sub-tidal systems will likely depend on the ability to find additional resources and leverage partnerships with other agencies. We are open to ideas for addressing this gap in our program.

Boston Locality Pay: As discussed in the Staffing and Budget section, it is likely that we will be included in the area receiving Boston locality pay beginning in 2004. In the first year, this would re-direct 4.5 percent of our budget to salaries, and incrementally more in subsequent years (given the compounding nature of locality pay with annual cost of living adjustments and step increases). At this time, the degree to which park base funds will be increased to cope with the added personnel costs are unknown. We would appreciate any forecast regarding the degree to which the I&M dollars coming as base funds might be increased to help offset this cost.

Staffing Plan: As discussed in the staffing section, we currently have unmet needs for hydrological and data management expertise. We have chosen to satisfy our data management needs by hiring a full-time data manager at the GS-11 level, and look for other means of acquiring hydrological expertise such as partnership with USGS and the Regional Hydrologist. We would appreciate any comments on this course of action and any recommendations for obtaining hydrological expertise on a regular basis.

Scientific and Statistical Review of Protocols and Monitoring Data: We look forward to inviting focused review of the statistical power of the data we will be collecting over the next several years. We are interested in any guidance regarding the optimal timing of such a review (e.g. how many protocols, how many years of data, similarity of protocols addressed by the review). We are also interested in establishing a formal relationship with USGS and the CESU to assist with long-term data analysis and protocol refinement.